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DRAINAGE.

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REPRINTED FROM THE
AMERICAN GYNAECOLOGICAL AND OBSTETRICAL JOURNAL
FOR MARCH, 1896.



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THE ADVANTAGES AND TECHNIQUE OF CAPILLARY ABDOMINAL DRAINAGE.*

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The time limitation on the present occasion demands that the subject assigned for discussion be treated in a manner so brief as to be almost fragmentary. I shall therefore invite your attention to but two general problems in abdominal drainage: first, the requirements demanded of a drain *in the free peritoneal cavity*, briefly explaining the reasons why I prefer capillary drainage; second, I shall occupy a few moments with a consideration of the best methods of utilizing the capillary drain, leaving to others, for the present, the large and important subject of the indications for drainage.

The first problem of drainage of the abdomen is the mechanical removal from the abdominal cavity of a certain quantity of fluid per hour for a certain number of hours. What is the quantity to be removed per hour, and what the number of hours during which this mechanical process must be kept up, we can not foretell even when individual cases are before us, since we have no means of estimating the secretory activity of the peritonæum on the one hand, or its resorptive power on the other. Consequently I conceive it a general principle which will be undisputed that when a drain is applied it must be of sufficient capacity to remove as many ounces of fluid per hour as the peritonæum under the pathological conditions present can possibly demand. Insufficient drainage, where drainage is employed at all, must be calamitous, especially in the presence of bacteria, which we know are present even in the majority of aseptic laparotomies, since the micro-organisms may grow in the accumulating fluids.

The operator who wishes to remove fluids from the abdomen thinks first of all of the various excavations and projections upon the posterior wall of the abdomen as being in his favor from a hydraulic point

* Read before the Chicago Gynæcological Society, January 17, 1896.



of view, since they have some tendency to cause the fluid to collect in puddles by force of gravity.

To withdraw large quantities of fluid from the abdomen in a given time Koeberlé first used the glass tube. To reach the bottoms of the various valleys of the abdomen Keith lengthened and, where necessary, bent the tube.

Keith's improvement was long the ideal of abdominal drainage. But neither Koeberlé nor Keith had fully overcome two other important physical factors in the problem—viz., the action of gravity and the mechanical interference offered to drainage by the intestines.

The first of these difficulties was met by aspirating the contents of the tube at stated intervals, a process which leaves the tube, at best, with some vestiges of fluid in it, and which between the acts of aspiration permits the bacteria, as Welch has pointed out, to overcome the bactericidal action of the fluid and grow in it, provided, as they are, with a retreat safe from contact with the tissues. Besides, we must not neglect the great danger of infecting the tissues about the tube at the frequent dressings.

It remained for capillary drainage to solve both these problems at once, the strands or masses of capillary material being placed, if necessary, between the intestines or other viscera, and at the same time elevating the fluid to the dressings outside the abdominal cavity. We have now learned that the application of the gauze directly to the infected or injured surface insures the immediate removal of the secretions to a safe distance.

Thus we see that the most fundamental principles of wound treatment are violated by the use of the drainage-tube in the abdomen, while the capillary drain fulfills these requirements.

A physiological requirement is likewise met by capillary drainage and violated by tubular drainage—viz., that a minimum of damage must be inflicted upon the peritonæum. The unyielding glass tube inevitably injures the delicate peritonæum when pushed and pulled about by the respiratory and other movements of the abdominal walls, and by the vermicular action of the digestive tube. The gauze yields easily to all pressure from without, and injures the peritonæum to so slight an extent that most writers regard its effects in producing adhesions, aside from the coincident action of bacteria, as almost if not quite *nil*. Kelterborn* lays special stress on the action of infection as the most important factor in the causation of adhesions.

* *Cent. f. Gyn.*, No. 51, 1890.

The value of capillary drainage is great in meeting the requirements of a means by which currents of infectious fluid may be diverted from uninjected areas and the morbid tissues be inclosed and cut off from the normal areas.

No case with which I am familiar illustrated so many advantages of capillary drainage as one mentioned by Gubaroff,* in which a section was made upon the body of a woman who had submitted to intestinal resection of the colon. The patient had died thirty-six hours after the operation as a result of a purulent and very malignant peritonitis. All those points which had been in contact with the gauze were entirely healthy, and the serous coverings of the viscera had preserved not only their pale tone of color, but also a part of their polish. About ten centimetres around the drainage material the intestine was inflamed and covered with thin fibrinous pseudo-membrane; here there were no signs of pus demonstrable, although the gauze had come in direct contact with those places where the intestinal ends had been sewed together and where one would expect a leakage of intestinal contents. In the neighborhood of these adherent points—*i. e.*, ten centimetres from the surface of the drain—one came into the peritonitis area.

The influence of the drain, we may safely infer, extends at least ten centimetres in every direction about the gauze.

A very great advantage of the gauze drain lies in the fact that its presence, by favoring the destruction of a certain number of peritoneal cells and of white corpuscles, brings about a rapid coagulation which materially favors the arrest of haemorrhage. The impossibility of reaching the various anatomical subdivisions of the abdominal cavity by means of tubular drains needs only to be mentioned.

Here, again, the gauze has an important advantage, since it may be harmlessly pushed in various directions in the abdominal cavity. This advantage some operators, it seems to me, very thoughtlessly disregard when they roll their gauze into cylinders, as advised by some writers.

The length of time a capillary drain is to be left in the abdomen is a delicate point to decide. Gubaroff, already cited, thinks that twenty-four to thirty-six hours is sufficient time for a gauze drain to lose its usefulness in a normal peritoneal cavity by the process of adhesive peritonitis walling it off and mechanically preventing its further action. Graser's recent beautiful researches on adhesive perito-

* *Arch. f. Gyn.*, Bd. xlix, H. 2.

nitis bear out this opinion and the similar recorded results of earlier observations. But in the presence of infection and of acute inflammation the case is widely different. So long as the discharge is free, few of us will feel like removing the gauze lest peritonitis be the result. We must not forget that a capillary drain may, after several days' use, deliver less fluid because of its surface being to some extent covered up and blocked by a fibrinous deposit or by the accumulation in its meshes of quantities of cells, the gauze acting like a filter, so that for chronic discharges tubular drains give better service.

It would be wrong to omit the mention of the great assistance that both tubular and capillary drainage receive from intra-abdominal pressure. Tubular drainage is especially dependent upon it.

The value of capillary drainage depends, first, upon the material selected, and secondly upon the skill displayed and the method chosen in its application. These matters have, I believe, been too little analyzed by writers on abdominal technique, although experienced operators do not go astray.

In the first place, the choice of material would theoretically demand the use of fibers of a minimum diameter, since the activity of capillary movements varies inversely with the diameter of the capillary tube. Hence we would select, if this were the only consideration, silk or spun glass. For the same reason we would choose a fabric of a very fine mesh in order that a maximum number of conducting tubes might be included within a given sectional area. Practically, however, these considerations are outweighed by the fact that our ordinary hydrophile cotton gauze has been found universally efficient, since its volume can be increased sufficiently to meet the physical requirements. Cheapness and convenience are additional advantages of gauze.

But too much importance can not be ascribed to the proper preparation of the gauze. It should be free not only from added gums or resins, but also from the oil of the crude cotton fabric. It should be as actively "hydrophile" as possible. Doubtless every surgeon has met with cases in which commercial gauze, by failing to attract water, has acted as an obturator instead of a drain. If gauze is properly prepared, lamp wicks have no advantages from a capillary point of view, while their limitations of thickness, length, and breadth are a distinct disadvantage.

The position of the patient in the application of the drain is not too unimportant to be worthy of mention. The elevation of one end

or side of the operating table will cause the intestines to move in the direction desired.

It is important that the strips of gauze be carried in each instance to the bottom of the abdomen, for if this is neglected fluid will collect below the gauze. The gauze will tend to be displaced by intestinal movements and will be rolled into useless ropes, lacking sufficient contact with the peritonæum to produce the friction necessary to hold it in position.

In operations in which septic foci are likely to be opened it has seemed to me good practice to apply at once on opening the abdomen those layers of gauze considered necessary as permanent protecting material. The pus is then caught on sponges and the drainage left undisturbed, since its removal and replacement inevitably results in contamination of the uncovered parts.

As has already been said, the quantity of gauze introduced must be sufficiently large to insure ample drainage; otherwise it may, by blocking the exit of fluids, do more harm than good.

I desire to present to the Society a simple device by which the draining power of gauze masses may be greatly increased. If two pieces of gauze of the same quality and breadth, but of different lengths, be hung over the edge of a receptacle containing water in such a way that both project equally into the fluid, it will be found that the longer piece of gauze will deliver from the receptacle a strikingly greater quantity of water than the shorter piece.

At first I thought this was due to a siphon action. But the slightest consideration served to show that as the individual fibers are not air-tight tubes extending continuously from the surface of the water in the reservoir to the end of the gauze, the conditions of siphonage are not supplied.

The explanation lies in the fact that, in the case of the long strip of gauze, the water is removed from the overhanging arm with great rapidity, the downward movement being accelerated by gravity as well as by downward capillarity in the overhanging part. While these forces act in the case of the short strip in exactly the same way they do not act in the same degree.

This is better understood by referring to the familiar movement of oil in a lamp wick when the oil at the top of the wick is ignited. A large volume of oil passes upward because the upper end of the wick is kept dry by the flame, which consumes the oil as fast as delivered; but before the lamp is lighted no oil flows out.

The practical application is: *Provide for free, perfect delivery of*

abdominal fluids from the drainage gauze. This may be done in two ways: The first and best, by leaving the strips of gauze long enough to fall over the patient's flank into the dressings at the side and back. The second method consists in the careful adjustment of the hydrophilic dressings in such a manner about the drainage gauze that a capillary joint between the two will be effected.

In several recent cases of appendicitis in which these plans were carefully followed, the enormous serous discharge wet the bedding beneath the patient repeatedly, while some of the cotton at the surface of the abdominal dressing was scarcely moistened. The extreme importance of employing cotton and gauze of unimpeachable hydrophilic quality needs only to be mentioned to be appreciated.

The following propositions seem to me to be justly deduced from the foregoing considerations:

1. Since the quantity of fluid to be removed per hour can not be more than approximately estimated, the amount of drainage material employed must be well equal to maximum requirements.

2. Capillary (gauze) drainage has the advantage over tubular drainage that a minimum amount of damage is inflicted upon the peritonæum.

3. Capillary drainage acts independently of gravity and suction apparatus, and delivers a constant current of fluid.

4. By its appropriate disposition among the peritonæum-clad viscera it not only aids coagulation in ruptured capillaries, but carries away fluids secreted at some distance (ten centimetres) from the limits of the gauze, since capillary action takes place between the closely approximated peritoneal surfaces.

5. The amount of plastic reaction depends more upon the infection present than upon the action of the gauze.

6. The utmost attention should be paid in septic cases to the accurate application of gauze over the uninfected surfaces of the peritonæum near the focus of infection, and this gauze should not be disturbed or replaced during or at the end of the operation.

7. The strips of drainage gauze should be left long in order that, hanging over the side of the abdomen, the fluid from the peritonæum may be delivered with great freedom and rapidity into the dressings.

